The pair of clusters Abell 222 / Abell 223: an XMM-Newton and optical view

Florence Durret [1,2], Tatiana F. Laganá [3], Christophe Adami [4] and Emmanuel Bertin [1,2]

1. UPMC Université Paris 06, UMR 7095, Institut d'Astrophysique de Paris, F-75014 Paris, France
2. CNRS, UMR 7095, Institut d'Astrophysique de Paris, F-75014 Paris, France
3. IAG, USP, Rua do Matão 1226, 05508-090 São Paulo/SP, Brazil
4. LAM, Pôle de l'Etoile Site de Château-Gombert, 38 rue Frédéric Joliot-Curie, F-13388 Marseille Cedex 13, France

The pair of clusters Abell 222/223 is at a redshift z=0.21.
An X-ray emitting filament has been detected between the two clusters by Werner et al. (2008)
Based on optical spectroscopy Dietrich et al. (2002) have shown that Abell 222 is relatively relaxed while the galaxies in Abell 223 are distributed in a double structure.

We investigate here the structure of the two clusters forming the Abell 222/223 pair, based on
- Temperature and metallicity maps of the X-ray gas computed from XMM-Newton archive data
- Optical galaxy luminosity functions based on CFHT/Megacam data extracted from the CADC Megapipe archive

X-ray analysis and results

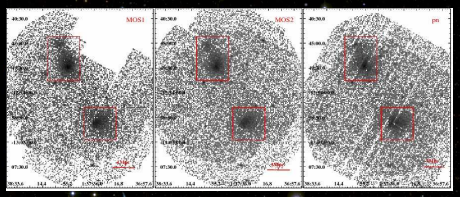

Fig. 1. Merged event maps from MOS1 (left), MOS2 (centre) and pn (right), showing the regions where the 2D maps were obtained

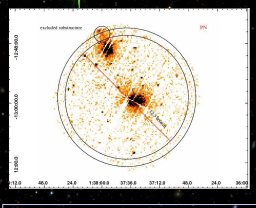

Fig. 2. Annulus where the background was extracted for subtraction (the small circle was excluded)

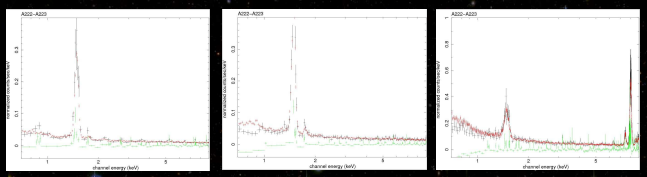

Fig. 3. Comparison of the observed and Read backgrounds for MOS1 (left), MOS2 (centre) and pn (right). The black points correspond to the observed data, the red points to Read's scaled background and the green points to the residuals.

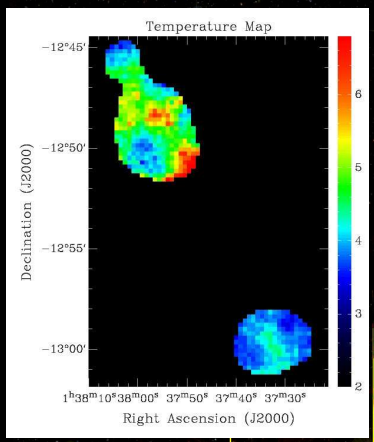

Fig. 4. Temperature map of the X-ray gas (colour scale in keV).

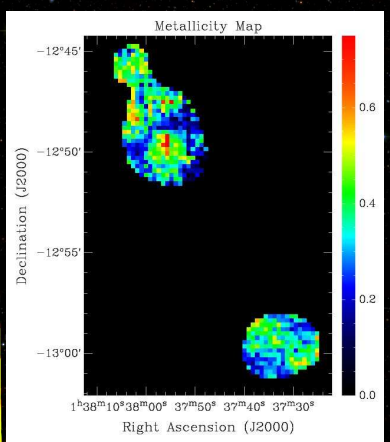

Fig. 5. Metallicity map of the X-ray gas (colour scale in solar values).

Main X-ray results

- Abell 222 is quite relaxed, but shows no cooling core
- Abell 223 is strongly perturbed; the small subcluster to the north east has probably just crossed Abell 223, which is likely to be falling on to Abell 222

Optical analysis and results

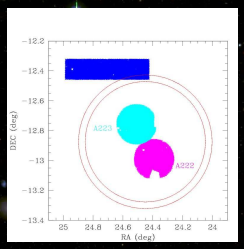

Fig. 6. Field covered by the CFHT/Megacam g and r band images., with the zones corresponding to the two clusters. The statistical background contribution was extracted in the red annulus and blue rectangle.

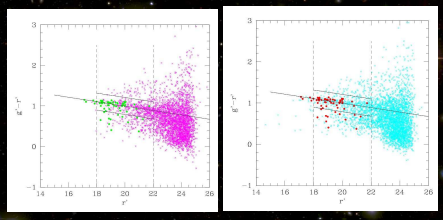

Fig. 7. Colour-magnitude diagrams for A222 (left) and A223 (right), showing the cluster red sequences along which cluster members were selected at bright magnitudes. Spectroscopically confirmed members are displayed in different colours.

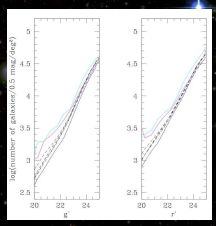

Fig. 8. Galaxy number counts in g (left) and r (right), with A222 in magenta, A223 in cyan, and various statistical background counts (CFHTLS-Deep and blue rectangle in Fig. 6).

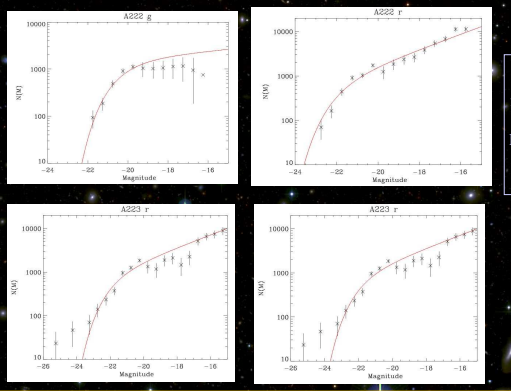

Fig. 9 Galaxy luminosity functions in the g and r bands for A222 and A223. Fits with a Schechter function are shown in red.

Discussion

• Abell 222 has galaxy luminosity functions (Fig. 9) showing a lack of faint blue galaxies in g (hence few star forming galaxies) and a smooth aspect in r (well fit by a Schechter function). Its temperature and metallicity maps (Figs. 4 and 5) are quite smooth, suggesting that it is not too far from a relaxed state. However, the absence of a cool core (Fig. 5) precludes a fully relaxed state.

• Abell 223 has galaxy luminosity functions that cannot be fit by single Schechter functions. It is much richer in faint blue galaxies that Abell 222, suggesting that star formation has been triggered by recent interactions in Abell 223. This and the strongly perturbed X-ray temperature and metallicity maps. Indicate that Abell 223 has probably been crossed by a subcluster on its way to the northeast, and is presently falling on to Abell 222.

• The linear distribution of the two main substructures found by the Serna & Gerbal (1996) method (see Fig. 10) confirms that both clusters are not well relaxed systems.

A full description of this work can be found in Durret, Lagana, Adami & Bertin 2010, A&A in press (soon in arXiv)

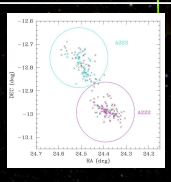

Fig. 10. Distribution of galaxies with spectroscopic redshifts. In black, all galaxies in the [0.18,0.24] redshift interval. In magenta and cyan, galaxies belonging to the two main gravitationally bound structures found with the Serna & Gerbal (1996) method.

References
Dietrich J.P., Clowe D.I., Soucail G. 2002, A&A 394, 395
Dietrich J.P., Schneider P., Clowe D., Romano-Diaz E., Kerp J. 2005, A&A 440, 453
Werner N., Finoguenov A., Kaastra J.S. et al. 2008, A&A 482, L29

Acknowledgements. We thank G.B. Lima Neto, A. Biviano, S. Gwyn and D. Russeil for their help at various stages of this project. This work was supported by FAPESP (grants 2006/56213-9, 2008/04318-7).